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Occasional Note No. 32 (Agr Memo No. 333)

An examination of some observations of wind-run at 2 metres above ground level, at several agrometeorological stations

(by R W Gloyne & Miss T Kennedy)

Introduction

During an observational study of livestock behaviour on a hill area some years ago at the Hill Farming Research Organisation's Experimental Farm at Sourhope near Kelso; it was necessary to log wind-run at 2 metres on an exposed hill summit at 1200 ft above MSL.

Information on wind in various terrains is relatively sparse and the opportunity has been taken to present and discuss some data. "Wind-runs" for agrometeorological stations are published by the MAFF in terms of "Shaw weeks" (ie successive 7-day periods starting on Nov 6 of each year and running for 52 weeks until Nov 4; with Nov 5 and, in leap years, Nov 4 and 5 not allocated to a "Shaw week").

Readings at Sourhope consisted of wind-run at 2 m above the surface for periods of from 3 to 7 days. From these data cumulative graphs were produced and, assuming linear interpolation, the increment for successive Shaw weeks obtained. "Weeks" were then aggregated into nominal "months" of 4 or 5 weeks and these grouped into "seasons" (the "Spring" "Summer" etc of Table 1) and finally aggregated into a 53 week (ie an annual) total.

From the "Summary of observations at agro-meteorological stations" published by the Ministry of Agriculture Food & Fisheries, the wind-runs for the corresponding weeks for a selection of stations were extracted and totalled for the same nominal "months" and "seasons" as defined above.

Analysis of Data

The stations for which data have been extracted are identified in Fig 1.

In Table 1 the "monthly" wind-run for Sourhope is given in miles, the results for all the other stations being expressed as a percentage of that registered at Sourhope.

Over an area as extensive as that considered we can expect place to place differences, differences with time (eg month to month, year to year) and place X time interactions. An attempt was made to minimise the effects of the second and third sources of variability, and so to reveal the basic underlying geographical differences. This was done by selecting one or more standard anemograph stations to be associated with a particular agrometeorological station deemed to reflect the wind regime at the latter stations. The wind-run at the anemograph station in 1957 was then expressed as a percentage of the mean value for 12 years (1956 to 1967 inclusive). The year was found to be rather less windy at most places that the longer period average by up to 10% or so. The exceptions appeared

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to be Sourhope (our assumed base-line station, where the 1957 "run" was judged to be close to the 12 year average) and Kirkham (Lancs) which was flanked in the North by Fleetwood and in the South by Speke (Liverpool Airport) where the 1957 winds were 10% or so above their longer period averages. In Table I, percentages relating to the annual total based on estimates adjusted for such deviation from "normal" are shown in brackets.

Discussion

(a) Place to place variability - relative values

When ranked in order of decreasing wind-run, the results both for individual "season" and the "year" as a whole were similar, the "seasonal" positions of most stations remaining within ± one of that indicated for the "year". Rosewarne (Cornwall) was consistently second registering a wind-run about 75% of that at Sourhope) High Mowthorpe usually next, and with Cawood (Stockbridge House EH5, Yorks) and Kirkham (Lancs) usually occupying the last two places in the sequence (their figures being from 40-45% of the Sourhope value and a little over one-half of the run experienced at, perhaps, the windiest of all the Experimental Horticultural Stations viz Rosewarne).

(b) Place to place variability - absolute values

The annual mean speeds ~~at Sourhope~~ in 1957-8 adjusted to 10 m above ground level (viz the 2 m result x 1.29) were as under:

Sourhope	17 mph	Kirkham	7 mph
Stanhope	9 "	Pershore	7½ "
High Mowthorpe	10½ "	Luddington	9½ "
Cawood	7 "	Efford	9 "
Terrington	7 "	Rosewarne	11½ "

(For a longer period comparison all should be increased by about 10% except for Sourhope - no change - and Kirkham, a tentative reduction of 10%). The stations are listed above approximately running north to south - the left hand columns for the eastern side of Great Britain and the right hand side for the western half.

Clearly height above sea level and nearness to the sea are necessary but not sufficient conditions for a high value for wind-run. Stanhope, although at 742 ft above MSL lies in a half-mile wide north-south valley floor of the Upper Tweed; to the east the level rises in four miles to a ridge of general height 2500 ft, and to the west in less than one mile to 1800 ft, the distances between the lines of the two ridges thus being about 5 miles. By contrast the site at Sourhope (1200 ft) is near the summit of a collection of hills most of which, within a radius of several miles are of approximately this length.

The contrast between the "run" at the neighbouring stations Luddington where the exposure is known to be "open" and Pershore should be noted. The value at Efford is lower than would be anticipated in general grounds, as is that at Kirkham. However these facts - as well as some to be mentioned below (Section (c)) - illustrate the importance of the character of the immediate surroundings in relation to wind exposure.

For a longer period estimate it has been suggested that 10% might be added to the speeds of all but two (viz Sourhope and Kirkham) of the stations, thus approaching comparability with the results set out in the Climatological Atlas (1952 p 20). This indicates an annual mean speed at 10 m of 15 mph or more along the west coasts of Cornwall, Wales and Scotland and reaching 17½ mph over the Outer Hebrides (much as suggested for Sourhope). In all other areas the Atlas gives rather higher speeds than listed above. The greater part of the central mass of England is allocated mean speed of 10 mph, higher values are given for most of Scotland, England south-westwards from Wiltshire over Wales and much of E Anglia, and elsewhere within 50 miles or less of the coast. Cawood, Kirkham, Efford, Terrington and Pershore would

would, on the above basis, be judged somewhat anomalous.

(c) Some special considerations

(i) Studies underway on the wind regime at Stanhope show that the mean wind speed at 2500 ft above MSL (and hence at the general summit height in the area)is about $2\frac{1}{2}$ times that at 741 ft: we thus have comparative figures of

Stanhope	(741 ft)	9 mph
Sourhope	(1200 ft)	17 "
Stanhope	(2500 ft)	23 " (est)

As confirming the general level of annual windspeed on the summits of hills in the Southern Uplands of Scotland, we may quote Lowther Hill (Lanarks. 2400 ft above MSL) a mean annual figure, (1962-68 incl) of $19\frac{1}{2}$ mph.

It may be of interest to recall some findings on the role of wind in limiting vegetational growth.

Putnam (1948) defined a sequence of deformations of tree growth by wind from "brushing" to "tree carpet" (ie having virtually no vertical growth), which, for a range of species of trees occurs within the limits of 17 mph to 27 mph (at specimen height). He quotes Balsam, Spruce and fir held to 1 ft heights at 27 mph (to 4 ft at $21\frac{1}{2}$ mph) and found marked deformation of tree crowns at a level of 30 ft when mean annual wind speed at that height reached about 19 mph.

Golding and Stodhart (1952) noted that only sites with mean annual wind speeds between 20 and 25 mph (at the standard height of about 30 ft) are likely to be suitable for wind driven generators and that such are devoid of trees, carrying at best low scrub or heather - the latter often clipped to 6 to 12 inches.

Winter (1964-65) reported considerable reduction in growth of Spring Cabbage and Lettuce at speeds corresponding to 20 mph at standard height.

Amongst the extensive literature on the effect of wind on the growth of certain species, we may quote Hogg and Ibbett (1956) and Hogg (1962) where it is noted that at Rosewarne crop yield increased with shelter and hence that the wind régime experienced at this station does constrain growth.

(ii) The results for Cawood (Stockbridge House) deserve additional mention.

Hogg (1961) points out that the readings from the station anemometer were increasing prejudiced by the growth of shelter belts and in 1968 a new instrument site was chosen overlapping readings suggested that an under-estimation of the order of 25% had built-up by the time of the change. Hence our results (for 1957) might fairly be increased to c. 9 mph and thus more in line with a general qualitative estimate of the degree of exposure experienced in the Vale of York

Tentative Conclusions

1. In parts of the southern Uplans where bare rounded summits reach a general height of say 1000 to 1500 ft the mean annual windspeed at 30 ft above ground level probably lies between 16 and 20 mph. This figure should be compared with the 17 mph mean annual speed experienced at low levels in the Outer Hebrides and similar parts of west and north-west Scotland.

2. When the general level of summit reaches 2500 ft, the mean speed rises to 25 mph or so.

3. Wind speeds in valleys a 1000 ft or more below the general level of the summit is more likely to average about 10 mph.

4. In the lower hills (c. 500-600 ft) of Norther England where relatively intensive farming is carried out the annual mean speed possibly range between 10 and 15 mph.

5. In some coastal areas - notably a few hundred feet above sea level in the Devon and Cornwall - the mean speed ($12\frac{1}{2}$ mph) exceeds that in other, higher areas (see 3 and 4 above).

6. This study re-emphasises the well-know difficulties on siting anemometers to register a general wind over an area. The less the height of the anemometer above ground level, the greater is likely to be the unavoidable influence of e.g. surface features, crops, hedges, trees, fences, buildings etc. At the standard height of 10 m the effect of the low obstructions on wind registered is minimised. Against this must be laid the fact that the airflow regime influencing crops, animals buildings etc in any particular situation might well be better expressed in terms of wind at 2 m. than one at 10 m.

Obviously therefore any serious study of wind regime in the context of agriculture etc must take account both of the general regime (as defined by weather maps, by the wind registered by the standard Meteorological Office network of anemograph disposed over the countryside and sited according to the best practice), as well as of on-site measurements at (say) 2 m. above ground.

References

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Any comments or suggestions on this paper should be sent to the authors.

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Table I. Wind run (in miles) at 2 m. for stated "months" and periods in 1957-8 at Sourhope Exp. Farm (Hill Farming Res Org.) and percentage of run registered at several Agro-meteorological Stations in Great Britain

In brackets - approximate long-period percentage relationship. Sourhope 1957-8 average approx equal its period average

Period	Station and Ht above MSL (in ft)													
	Sourhope		Stanhope	Lephinmore	High Mowthorpe	Cawood	Kirkham	Bryn Adda	Luddington	Terrington	Pershore	Cleppa Park	Efford	Rosewarne
	1200 ft		741 ft	30 ft	574 ft	20 ft	78 ft	275 ft	150 ft	13 ft	130 ft	90 ft	51 ft	250 ft
	Run	%	%		%	%	%	%	%	%	%	%	%	%
"Feb" 1957	10290	100	59	-	57	35	41	-	49	38	48	37	55	73
"Mar"	10460	100	67	-	69	47	58	63	56	43	49	44	57	84
"Apr"	7960	100	53	-	77	49	39	64	61	60	45	48	65	71
"May"	8020	100	54	-	71	51	49	54	64	68	53	52	67	80
Spring (13 wks)	26440	100	60	-	72	49	49	60	60	57	49	48	63	78
"June"	8680	100	53	-	62	47	41	-	57	31	47	50	55	65
"July"	7000	100	44	54	58	47	51	61	66	26	53	58	68	93
"Aug"	11490	100	41	52	50	38	39	-	44	18	40	43	57	71
Summer (14 wks)	27170	100	46	-	57	44	43	-	55	25	46	50	60	76
"Sept"	10240	100	48	-	54	37	40	51	47	31	39	38	49	64
"Oct"	7860	100	61	-	63	39	36	-	45	27	37	39	51	64
"Nov"	10610	100	43	55	62	38	31	-	53	47	40	-	55	54
Autumn (13 wks)	28710	100	51	-	60	38	35	-	49	35	39	-	53	61
"Dec"	10600	100	60	70	64	43	41	-	59	46	45	39	48	59
"Jan" 1958	10330	100	54	59	57	41	43	-	61	47	45	37	52	69
"Feb"	12730	100	60	67	65	44	47	-	62	52	45	38	50	61
Winter (13 wks)	33660	100	58	65	62	42	43	-	60	48	45	35	50	63
Total for "Year"	115980	100	53(59)	-	62(65)	43(45)	43(39)	-	56(62)	41(46)	44(49)	- -	55(55)	69(77)

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